A Practical Introduction to AI

- A Proof of Concept using drones and machine learning to automate identification of invasive species
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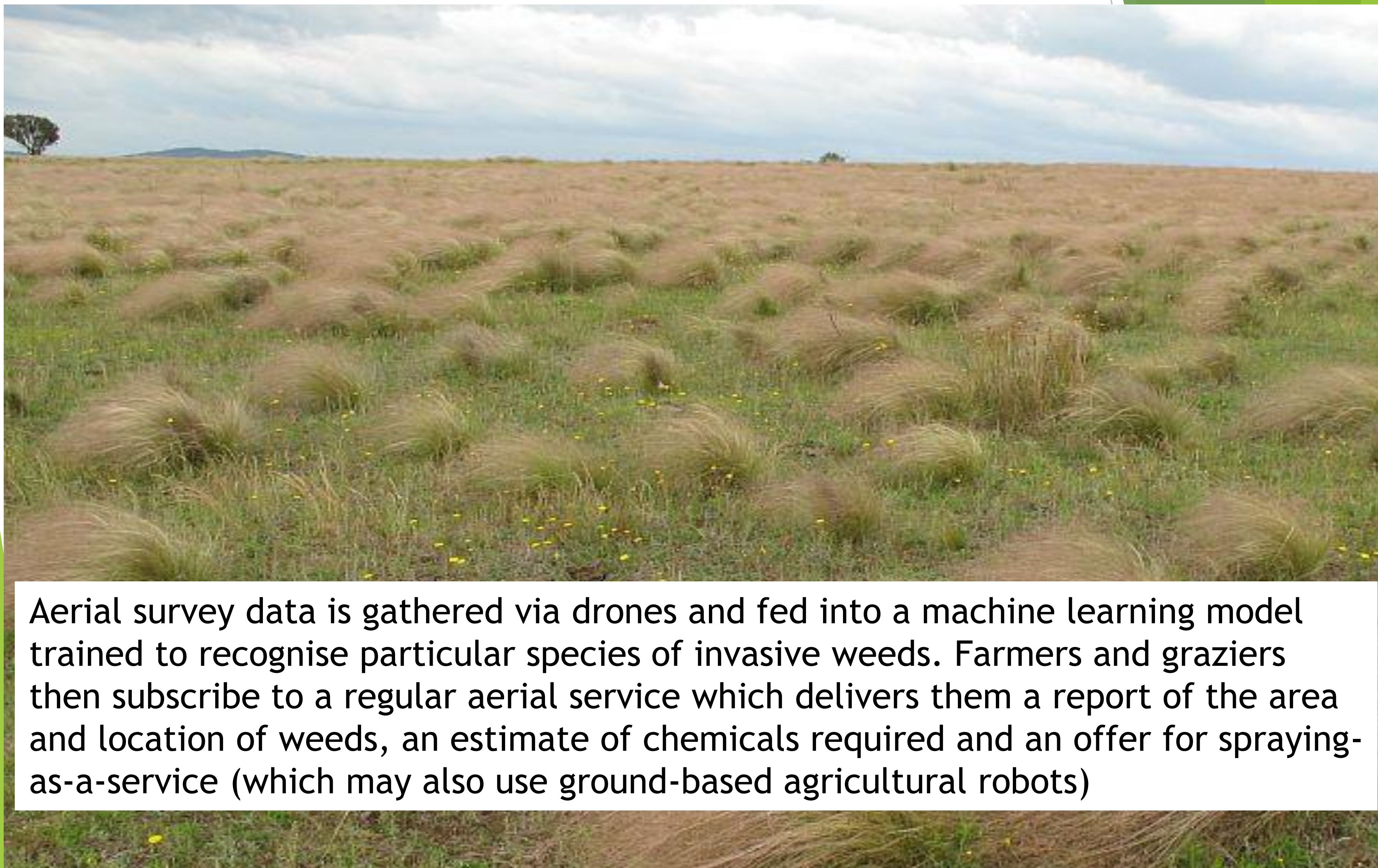
Problem

Weeds are a major threat to our unique natural environment, threatening the survival of hundreds of native plants and animals in NSW alone. They also impact on the price of food, human health through allergies and asthma, recreational activities and the NSW economy.

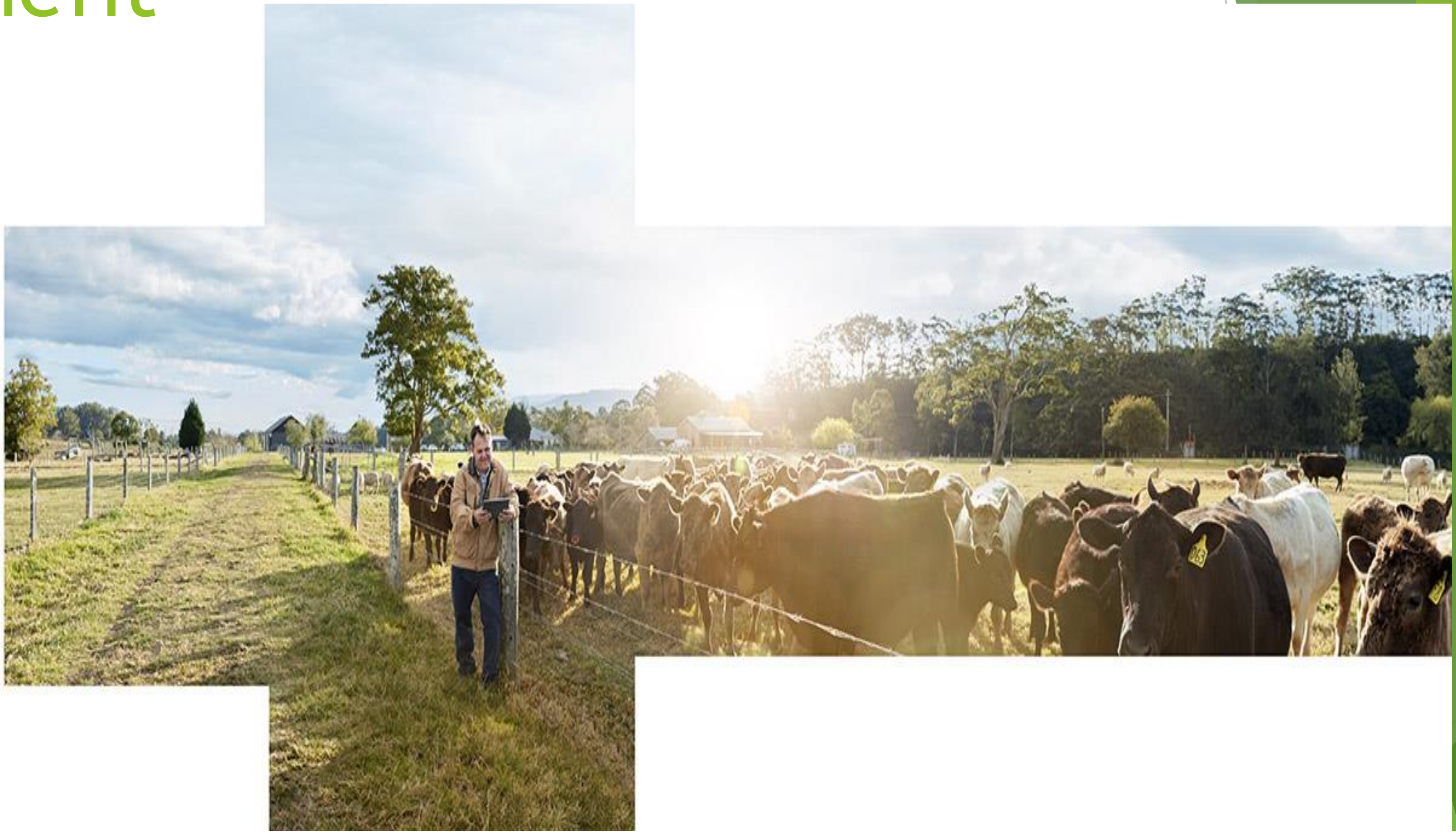
Weeds can colonise both native and introduced pastures, reducing the efficiency of the paddock as animals find the weeds unpalatable. Species like Serrated Tussock can develop into a monoculture within a few of years. Farmers spend a large amount of time and money controlling weeds and sometimes the chemicals used also carry compliance obligations that require the farmer to demonstrate the time elapsed from spraying to animals returning to graze on the paddock.

Idea



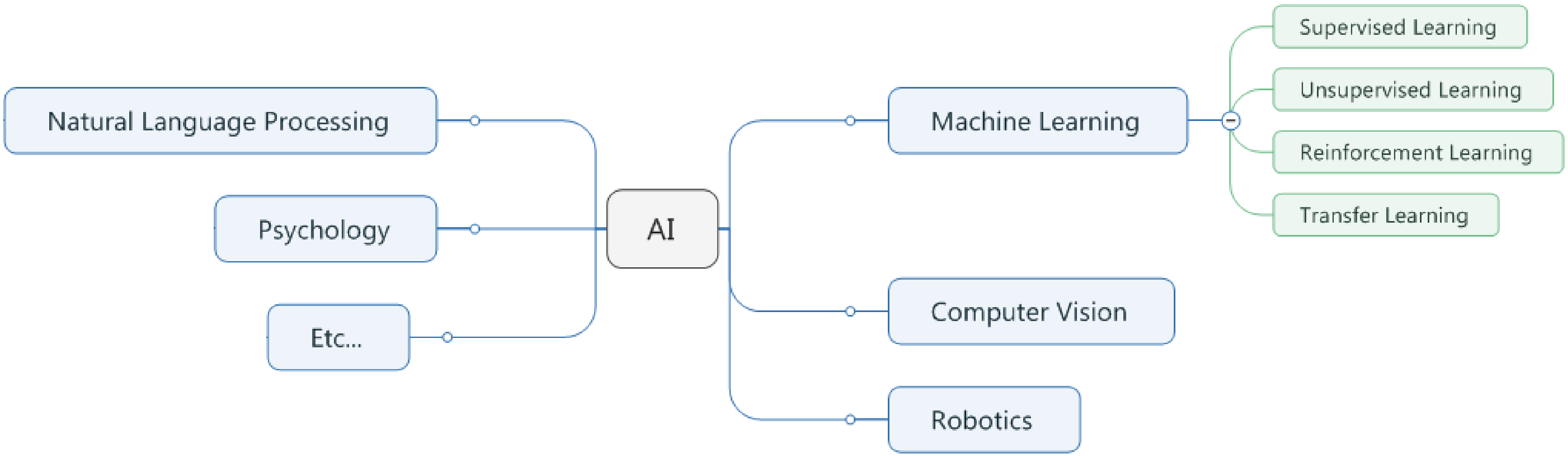
Aerial survey data is gathered via drones and fed into a machine learning model trained to recognise particular species of invasive weeds. Farmers and graziers then subscribe to a regular aerial service which delivers them a report of the area and location of weeds, an estimate of chemicals required and an offer for spraying-as-a-service (which may also use ground-based agricultural robots)

Benefit



Farmers can apply broad acre controls if they can show the infestation is > 50%, otherwise they must use expensive spot methods

What is Artificial Intelligence (AI) and why is it amazing?



How computers “see”

Neural networks model the human brain to learn hierarchical feature representations or “activation functions”

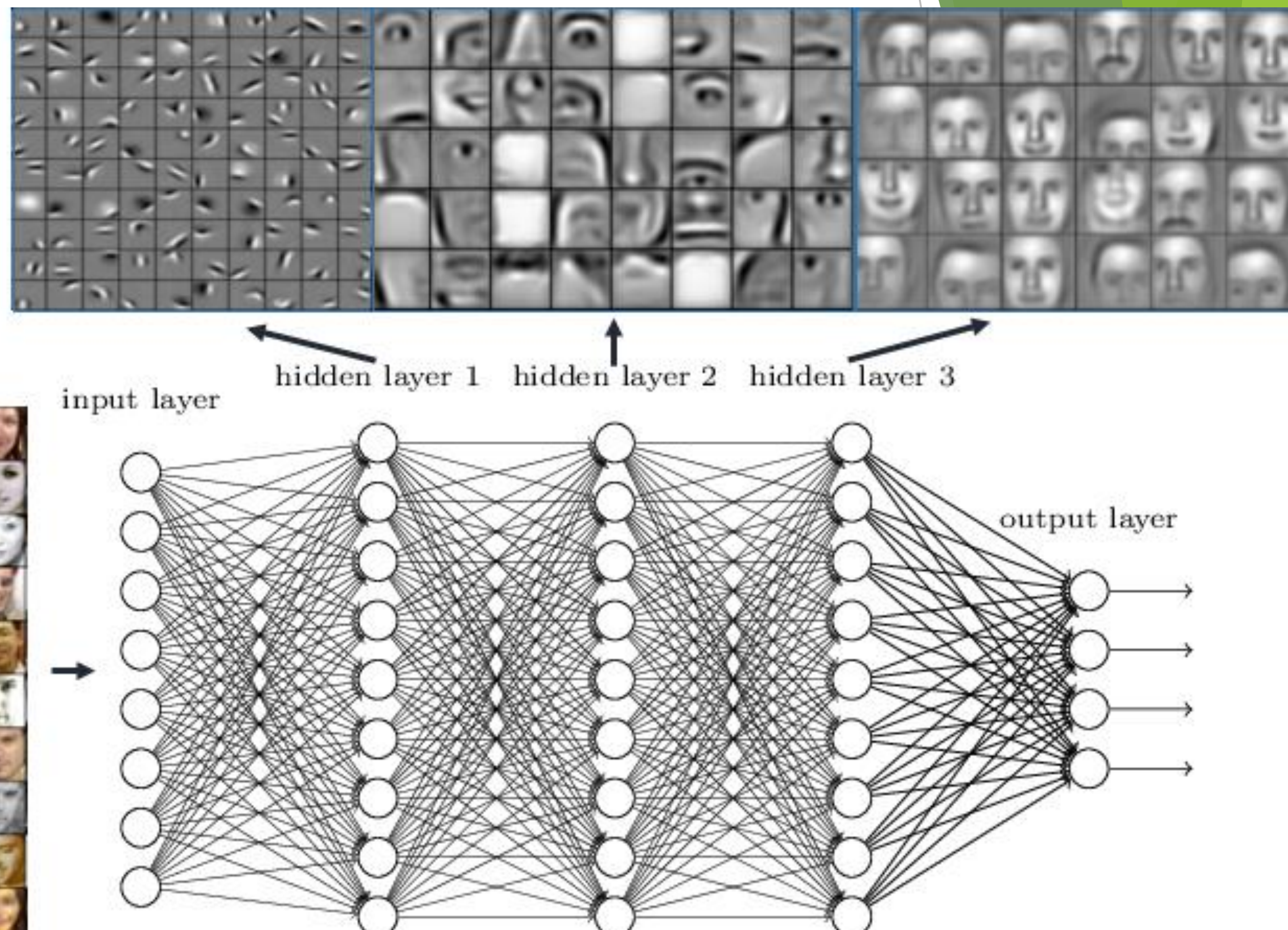


Image credit: https://www.rsipvision.com/exploring-deep-learning/

Proof of Concept Methodology

Proof of concept with the Snowy-Monaro council:

- Identify serrated tussock over about 300 acres with mobile phones and a Garmin GPS (538 data points collected)
- Drone operator performs an aerial survey of the paddock (2238 images collected)
- Extract the GPS waypoints from the Garmin GPS and tag the relevant aerial photos
- Train an algorithm to recognise serrated tussock in the aerial images

SEASON	SUMMER			AUTUMN			WINTER			SPRING		
MONTH	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV
SERRATED TUSSOCK *Nassella trichotoma*												NOXIOUS (4)
GERMINATION												
FLOWERING												
SEED FORMATION												
SEED DROP												
HERBICIDE	FLUPROPANATE: SPOT/BROADACRE											
OTHER CONTROL	CHIP; COMPETITIVE VEGETATION COVER; SPOT SPRAY GLYPHOSATE WHEN ACTIVELY GROWING											

Field Day 12 April 2018

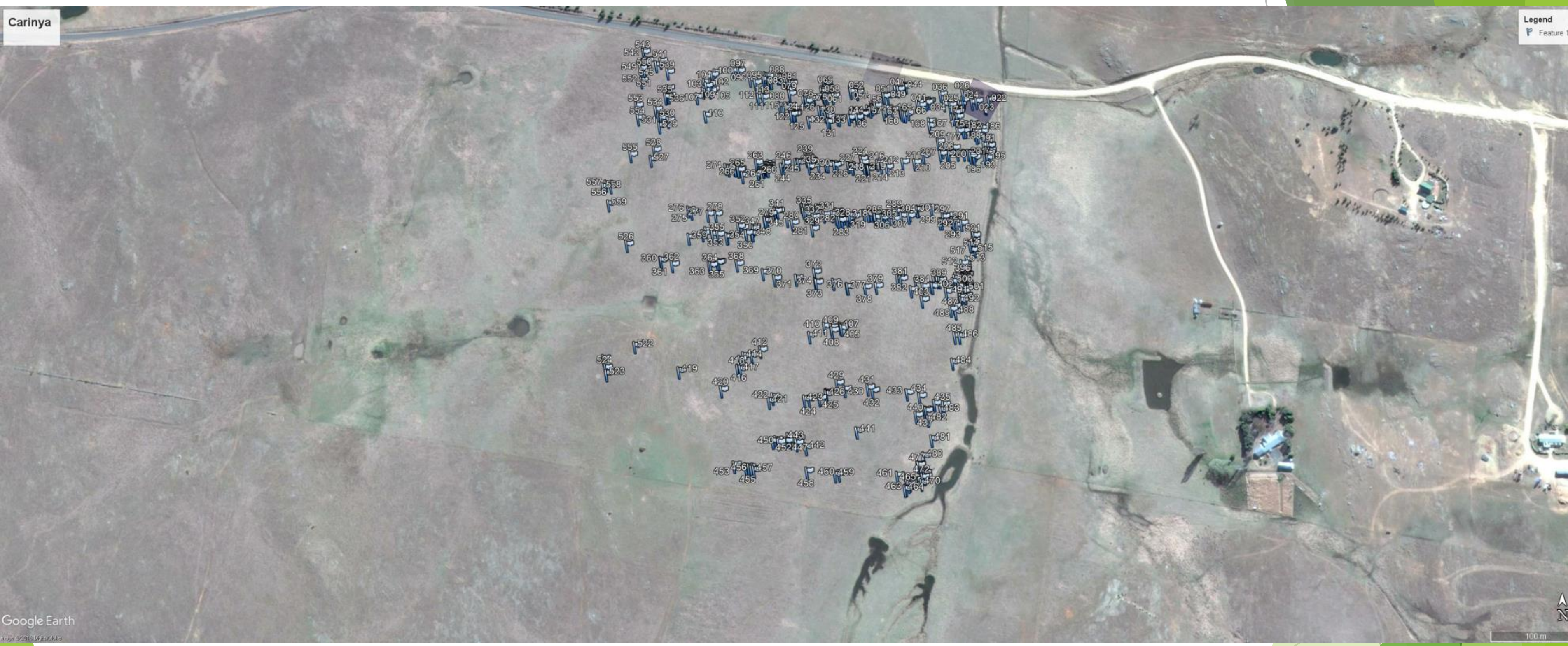
Snowy-Monaro council and ZRS Photography

Field Day 12 April 2018

Serrated Tussock up close

Serrated Tussock drone view

Plotting Serrated Tussock on Google Earth



Training the model

In [6]:
```
learn = ConvLearner.pretrained(arch, data)
%time learn.fit(1e-2, 3, cycle_len=2)
```

Epoch 100% 6/6 [1:41:44<00:00, 1017.42s/it]

epoch	trn_loss	val_loss	accuracy
0	0.804464	0.654346	0.568233
1	0.72563	0.636293	0.637584
2	0.722483	0.674498	0.592841
3	0.694154	0.654151	0.608501
4	0.696451	0.616493	0.63311
5	0.672797	0.614114	0.630872

Wall time: 1h 41min 44s

Out[6]: [array([0.61411]), 0.6308724821547267]

In [7]:
```
learn.unfreeze()
learn.bn_freeze(True)
%time learn.fit ([1e-5,1e-4,1e-2],1,cycle_len=1)
```

Epoch 100% 1/1 [17:08<00:00, 1028.91s/it]

epoch	trn_loss	val_loss	accuracy
0	0.662698	0.635906	0.644295

Wall time: 17min 8s

Out[7]: [array([0.63591]), 0.6442953028134851]

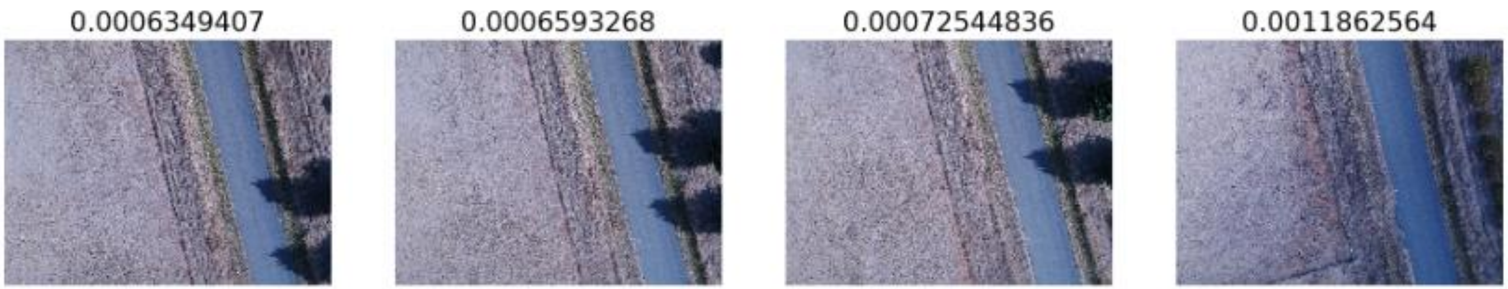
In [8]:
```
%time log_preds,y = learn.TTA()
```

Wall time: 16min 47s

Viewing some results

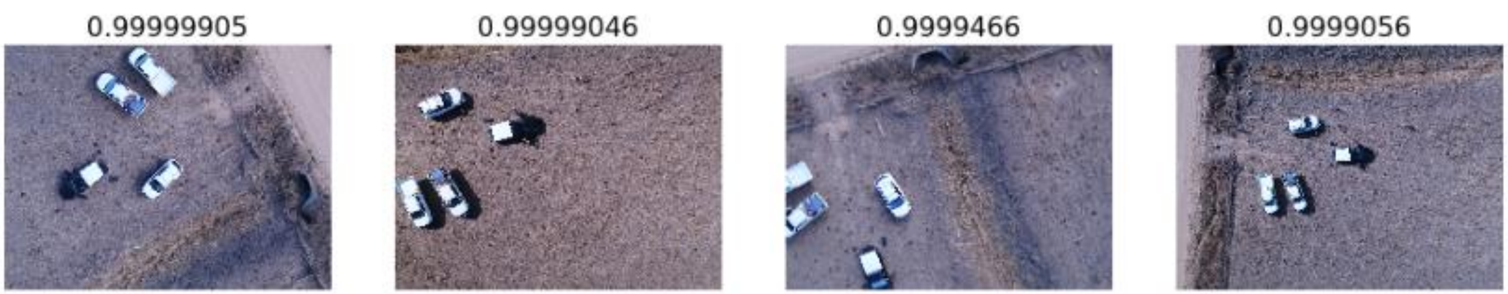
```
In [22]: plot_val_with_title(most_by_correct(0, True), "Most correct no tussock")
```

```
Most correct no tussock
```




```
In [23]: plot_val_with_title(most_by_correct(1, True), "Most correct tussock")
```

```
Most correct tussock
```

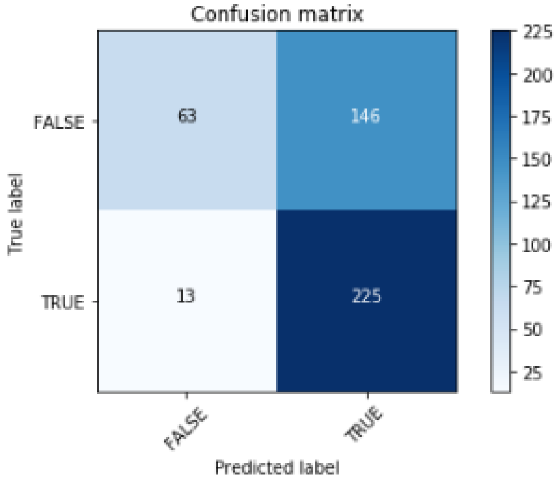


Viewing some results

```
In [28]:  cm = confusion_matrix(y, preds)

In [29]:  plot_confusion_matrix(cm, data.classes)

[[ 63 146]
 [ 13 225]]
```



Key Learnings

Citizen Science:

- ❑ Understand the problem
- ❑ End user (farmer) + Subject Matter Expert (weeds officer) + Technologist (geek)
- ❑ Collaboration is key

Data, data, data:

- ❑ The more the better
- ❑ Most of the hard work is preparation

Extreme Progress:

- ❑ Logarithmic time scales
- ❑ Experts are rare and will remain that way
- ❑ Our jobs as safe (for now…)

It’s not rocket science:

- ❑ Pick a framework and experiment
- ❑ The barrier to entry is surprisingly low for the value returned
- ❑ Stay up to date